1965/18

From *New Views of the Nature of Man*, John R. Platt (Ed.), 1965. U. Chicago Press. Reprinted 1966 in *Bull. Atomic Sci., J. Sci. & Pub. Affairs* 12(7):2-6 and 1967 in *Insight: Quart. Rev. Relig. & Ment. Health* 5(4): 7-12.

MIND, BRAIN, AND HUMANIST VALUES

by Roger W. Sperry

Science, Antiscience, and Values

As a scientist invited to discuss humanist implications of the brain-behavior sciences, I find myself feeling a little like one who has been asked to mount the stand in self-defense as the accused. As they say back in Grade Two these days, for every action there is an equal and opposing reaction; and the recent sharp boom in science has not come without a corresponding rise in the voices of antiscience. Some of the going complaints in this regard are no doubt familiar: It is not only that science is going to blow us all off the globe, or crowd us off with its programs for death control, but that even the good things resulting from science — the sum total of all the better-things-for-better-living — have failed, we are told, to add substantially to a genuine satisfaction in living. And when it comes to the more profound humanist concerns, the reasons for living and the meaning and the value of it all, science seems only to take away and destroy, they say, and then refuses on principle to answer for its actions or even to be concerned with matters of values.

To some, even the objective explanatory progress that science is supposed to be making toward truth and the great central mystery of the universe begins to look like merely a handy system of humanoid guesses and correlational probabilities with no

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real verification possible. Others liken our explanatory progress to the penetration of a great maze that gets ever bleaker, the innermost chamber of which, should it ever be reached, being likely to hold exactly nothing or perhaps just the self-reflections of the scientists' own thought processes. And then, about as fast as our comprehension and control of nature goes up, anti-science sees man's rating in the grand design going down.

Before going on, I had better explain that the reference to values above and in the title was not accidental, though I well realize that any mixing of values and science tends to serve as a red flag in some quarters. Some of us may already be wondering, Since when do scientists presume to carry a license for discussions of values? Value judgments, we have all heard, lie outside the realm of science. Value matters are for popes and prophets, for philosophers and perhaps boy scout and YMCA leaders, but not for science or scientists. As a student of brain and behavior, I have never been quite able to accept this. It seems the same as saying that value judgments lie outside the realm of knowledge and understanding. It is like saying that the best method we know of applying the human brain to problems of understanding must be discarded when it comes to problems of values. It is like saying that economics is riding under false colors in the National Science Foundation and ought to be exposed and expelled. And it is like saying that science is able to deal only with those phenomena and products of evolution that appeared prior to the emergence of higher brains, with their wants, needs, goal-directed properties, and, of course, the corresponding value systems that these impose.

Values have natural and logical origins. They are interdependent and interrelated in logical, hierarchical systems. These systems, and the perturbations thereof, ought to be subject to study and analysis and perhaps prediction and even some experimentation on a model basis these days, with computer assistance. I have always wondered whether rather little harm and perhaps much good in the long run might not come from opening

to the free winds of scientific skepticism and inquiry even the most revered of our traditional and cultural values.

Humanist Impacts of Behavioral Science

We can now turn to our main question, What have been the major impacts, from the *humanist* standpoint, of the recent developments in the sciences that deal with mind and brain? At first glance the record achieved by the brain-behavior sciences during the past half-century must seem to the humanist to read less like a list of contributions and advancements than like a list of major criminal offenses. The accusations that antiscience can raise in this area are not exactly trivial. For example, before science, man had reason to believe that he possessed a mind that was potent and full of something called "consciousness." Our modern experimental objective psychology and the neurosciences in general would divest the human brain of this fantasy and, in doing so, would dispense not only with the conscious mind but with most of the other spiritual components of human nature, including the immortal soul. Before science, man used to think that he was a spiritually free agent, possessing free will. Science tells us free will is just an illusion and gives us, instead, causal determinism. Where there used to be purpose and meaning in human behavior, science now shows us a complex biophysical machine with positive and negative feedback, composed entirely of material elements, all obeying the inexorable and universal laws of physics and chemistry. Thanks to Freud, with some assistance from astrophysics, science can be accused further of having deprived the thinking man of his Father in heaven, along with heaven itself. Freud's devastating indictment is said by many to have reduced much of man's formalized religion to little more than manifestations of neurosis.

Man's inner self and his heritage have not fared much better. Thanks to Darwin, and to Freud again, man now enters this life, not trailing clouds of glory, as the poet once had it, but trailing instead clouds of jungle-ism and bestiality, full of carnal

impulses and a predisposition to Oedipal and other complexes. The enduring veneer of our civilization is seen to be superficial and when it rubs thin or cracks, the animal within quickly shows through. These and related lesser onslaughts on the worth and the meaning of human nature tend to add up, one item reinforcing another, to yield a pretty dim over-all picture that is certainly not heartening to think about—and in science we generally don't think about it. Doubt and rejection of science by humanist thinkers in favor of other roads to truth is not hard to understand; and even for the scientist himself, the picture drawn by science imposes a severe test of his credo that it is better to know the truth, however ugly, and to live in accordance than to live and die by false premises and illusory values.

But for myself, speaking as a brain researcher—and one not too familiar with matters ethical and philosophical and hence in a position to speak with some conviction—I find myself and my hypothetical working model for the brain to be in marked disagreement with many, if not the majority, of the foregoing implications especially and with that whole general picture of human nature that seems to emerge from the currently prevailing objective, materialistic approach of the brain-behavior sciences. When the humanist is led to favor the implications of modern materialism over the older idealistic values in these and related matters, I suspect that he has been taken, that science has sold society and itself a somewhat questionable bill of goods. There is not space here to present the whole story behind these remarks, and so I will try to concentrate selectively on what would seem to be the centermost issues, hoping that if the central foundation of the materialist view can be undermined the resultant crumbling in the upper structures will become evident.

The Nature of Consciousness: The Central Issue

Most of the disagreements that I have referred to revolve around, or hinge either directly or indirectly upon, a central point of controversy that emerges from the following question: Is it possible, in theory or in principle, to construct a complete,

objective explanatory model of brain function without including consciousness in the causal sequence?

If the prevailing view in neuroscience is correct, that consciousness and mental forces in general can be ignored in our objective explanatory model, then we come out with materialism and all its implications. On the contrary, if it turns out that conscious mental forces do in fact govern and direct the nerve-impulse traffic and other biochemical and biophysical events in the brain and, hence, do have to be included as important features in the objective chain of control, then we come out at the opposite pole, or at mentalism, and with quite a different and more idealistic set of values all down the line. We deal here, of course, with the old mind-body dichotomy, the age-old problem of mind versus matter, the issue of the spiritual versus the material, on which books and books have been written and philosophies have foundered ever since man started to think about his inner world and to question its relation to the outer "real" world.

Let us begin by stating the case against consciousness and mind as raised by today's objective experimental psychology, psychobiology, neurophysiology, and the related disciplines. The best way to deal with consciousness or introspective, subjective experience in any form, they tell us, is to ignore it. Inner feelings and thoughts cannot be measured or weighed; they cannot be centrifuged or photographed, chromatographed, spectrographed, or otherwise recorded or dealt with objectively by any scientific methodology. As some kind of introspective, private, inner something, accessible only to the one experiencing individual, they simply must be excluded by policy from any scientific model or scientific explanation.

Furthermore, the neuroscientist of today feels he has a pretty fair idea about the kinds of things that excite and fire the nerve cells of the brain. Cell membrane changes, ion flow, chemical transmitters, pre- and post-synaptic potentials, sodium pump effects and the like, may be on his list of acceptable causal influences—but not consciousness. Consciousness, in the ob-

jective approach, is clearly made a second-rate citizen in the causal picture. It is relegated to the inferior status of (*a*) an inconsequential by-product, (*b*) an epiphenomenon (a sort of outsider on the inside), or most commonly, (*c*) just an inner aspect of the one material brain process. Scientists can see the brain as a complex, electrochemical communications network, full of nerve impulse traffic and other causally directed chemical and physical phenomena, with all elements moved by respectable scientific laws of physics, chemistry, physiology, and the like; but few are ready to tolerate an interjection into this causal machinery of any mental or conscious forces.

This is the general stance of modern behavioral science out of which comes today's prevailing objective, mechanistic, materialistic, behavioristic, fatalistic, reductionistic view of the nature of mind and psyche. This kind of thinking is not confined to our laboratories and the classrooms, of course. It leaks and spreads, and though never officially imposed on the societies of the Western world, we nevertheless see the pervasive influence of creeping materialism everywhere we turn.

Once we have materialism squared off against mentalism in this way, I think we must all agree that neither is going to win the match on the basis of direct, factual evidence. The facts simply do not go far enough to provide the answer, or even to come close. Those centermost processes of the brain with which consciousness is presumably associated are simply not understood. They are so far beyond our comprehension at present that no one I know of has been able even to imagine their nature. We are speaking here of the brain code, the physiological language of the cerebral hemispheres. There is good reason to believe that this language is built of nerve impulses and related excitatory effects in nerve cells and fibers and perhaps also in those glia cells that are said to outnumber the nerve cells in the brain by about ten to one. And we would probably be safe in the further noncommittal statement that the brain code is built of spatiotemporal patterns of excitation. But when it comes to even imagining the critical variables in these patterns that correlate with the variables that we know in inner, conscious experience, we are still hopelessly lost.

Furthermore, the central unknowns directly associated with consciousness seem to be rather well cushioned on both the input and output sides of the brain by further zones of physiological unknowns. Our explanatory picture for brain function is reasonably satisfactory for the sensory input pathways and the distal portion of the motor outflow. But that great in-between realm, starting at the stage where the incoming excitatory messages first reach the cortical surface of the brain, still today is very aptly referred to as the "mysterious black box."

To conclude that conscious, mental or psychic, forces have no place in filling this gap in our explanatory picture is at least to go well beyond the facts into the realm of intuition and speculation. The objective, materialist doctrine of behavioral science, which tends to be identified with a rigorous scientific approach, is thus seen to rest, in fact, on an insupportable mental inference that goes far beyond the objective evidence and hence is founded on the cardinal sin of science. One can still find here and there in the literature a modicum of some final, perhaps "last rite," respect paid to the psyche. For example, there is the acceptance by Charles Sherrington of the possible coexistence of two separate phenomenal realms in the brain, and there is the stand of Carl Rogers that man's inner experience must be recognized as well as the brain mechanism of objective psychology. In the existence of two such very different realms, Rogers sees a lasting paradox with which we all must learn to live. But even the dualists are quite prepared to go along these days with the conviction held by most brain researchers – up to some 99.9 per cent of us, I suppose – that conscious mental forces can be safely ignored, insofar as the objective, scientific study of the brain is concerned.

An Alternative Mentalist Position

In the pages that follow, I am going to line myself up with the 0.1 per cent or so mentalist minority in a stand that admittedly

also goes well beyond the facts. It is a position, however, that seems to me equally strong and somewhat more appealing than those we have just outlined. In my own hypothetical brain model, conscious awareness does get representation as a very real causal agent and rates an important place in the causal sequence and chain of control in brain events, in which it appears as an active, operational force. Any model or description that leaves out conscious forces, according to this view, is bound to be sadly incomplete and unsatisfactory. The conscious mind in this scheme, far from being put aside as a by-product, epiphenomenon, or inner aspect, is located front and center, directly in the midst of the causal interplay of cerebral mechanisms. Mind and consciousness are put in the driver's seat, as it were: They give the orders, and they push and haul around the physiology and the physical and chemical processes as much as or more than the latter processes direct them. This scheme is one that puts mind back over matter, in a sense, not under or outside or beside it. It is a scheme that idealizes ideas and ideals over physical and chemical interactions, nerve impulse traffic, and DNA. It is a brain model in which conscious mental psychic forces are recognized to be the crowning achievement of some five hundred million years or more of evolution.

Now, what is the argument in favor of mentalism, the argument that holds that ideas and other mental entities push around the physiological and biochemical events in the brain? The argument is simple and goes as follows: First, it contends that mind and consciousness are dynamic, emergent (pattern or configurational) properties of the living brain in action. There are usually plenty of "takers" on this first point, including even some of the tough-minded brain researchers, as, for example, the outstanding neuroanatomist, C. J. Herrick. Second, the argument goes a critical step farther and insists that these emergent properties in the brain have causal potency—just as they do elsewhere in the universe. And there we have the simple answer to the age-old enigma of consciousness. Who was it who said, that nothing is so simple as yesterday's solution, nothing so complicated as tomorrow's problems?

But let us spell out this answer a little further, since this whole subject has at times been a bit complicated. To put it very simply, it comes down to the issue of who pushes whom around in the population of causal forces that occupy the cranium. It is a matter, in other words, of straightening out the peck-order hierarchy among intracranial control agents. There exists within the cranium a whole world of diverse causal forces; what is more, there are forces within forces within forces, as in no other cubic half-foot of universe that we know. At the lowermost levels in this system, we have local aggregates of some sixty or more types of subnuclear particles interacting with great energy, all within the neutrons and protons of their respective atomic nuclei. These chaps, of course, do not have very much to say about what goes on in the affairs of the brain. We can pretty well forget them, because they are all firmly trapped and kept in line by their atomic overseers. The atomic nuclei and associated electrons are also, of course, firmly controlled in turn. The various atomic elements are "molecule-bound"—that is, they are hauled and pushed around by the larger spatial and configurational forces of their encompassing molecules.

Similarly, the molecules of the brain are themselves pretty well bound up and ordered around by their respective cells and tissues. Along with all of their internal atomic and subnuclear parts and their neighboring molecular partners, the brain molecules are obliged to submit to a course of activity in time and space that is very largely determined, for the lifetime of any given cell, by the over-all dynamic and spatial properties of the whole cell as an entity. Even the brain cells, however, with their long fibers and impulse-conducting properties, do not have very much to say about when they are going to fire their messages, for example, or in what time pattern they will fire them. The firing orders for the day come from a higher command.

In other words, the flow and the timing of impulse traffic through any brain cell, or even a nucleus of cells in the brain, are governed largely by the over-all encompassing properties of the whole cerebral circuit system, within which the given cells and fibers are incorporated, and also by the relationship of this cir-

cuit system to other circuit systems. Further, the dynamic properties of the cerebral system as a whole, and the way in which these properties direct and govern the flow of impulse traffic throughout the system—that is, the general circuit properties of the whole brain—may undergo radical and widespread changes from one moment to the next with just the flick of a cerebral facilitatory "set." This set is a shifting pattern of central excitation that will open or prime one group of circuit pathways with its own special pattern properties, while at the same time closing, repressing, or inhibiting endless other circuit potentialities that might otherwise be open and available for impulse traffic. These changes of "set" are responsible, for example, for such things as a shift of attention, a turn of thought, a change of feeling, or a new insight. To make a long story short, if one keeps climbing upward in the chain of command within the brain, one finds at the very top those over-all organizational forces and dynamic properties of the large patterns of cerebral excitation that are correlated with mental states or psychic activity. And this brings us close to the main issue.

We can take this argument a step further by looking at an illustrative example of one of these mental entities. For simplicity, let us consider an elemental sensation. Instead of philosophy's old favorite, the color red (the philosophic and geographic locus of which seems sometimes to be in some doubt), let us use another example, pain. To be more specific, let us say we are talking about pain in the fingers and thumb of the left hand, and let us pin it down further to pain in the left hand of an arm that was amputated above the elbow some months previously. You will recall that the suffering caused by pain localized mentally in a phantom limb is no easier to bear than that in a limb that is still there. It will be easier, however, by using this example, for us to infer where our conscious awareness does not reside.

In regard to the pain in a phantom limb, my contention is that any groans it may elicit from our patient and any other response measures or behavioral outputs that may be taken to be the result of the pain sensation are indeed caused not by the

biophysics, chemistry, or physiology of the cerebral nerve impulses as such, but by the pain quality, the pain property, per se. This brings us, then, to the real crux of the argument. Nerve excitations are just as common to pleasure, of course, as to pain, and the same is true of any other sensation. What is critical is that unique patterning of cerebral excitation that produces pain instead of something else. It is the over-all functional property of this pain pattern as a pattern that is critical in the causal sequence of brain affairs. This pattern has a dynamic entity, the qualitative effect of which must be conceived functionally and operationally and in terms of its impact on a living, unanesthesized cerebral system. It is this over-all pattern effect in brain dynamics that is the pain quality of inner experience. To try to explain the pain pattern or any other mental qualities only in terms of the spatiotemporal arrangement of nerve impulses, without reference to the mental properties and the mental qualities themselves, would be as formidable as trying to describe any of the endless variety of complex molecular reactions known to biochemistry wholly in terms of the properties of the electron, proton, and neutron and their subnuclear particles plus (and this, of course, is critical) their spatiotemporal relationships. By including the spatiotemporal relations, such a description becomes feasible in theory, probably, but fantastically impractical. Moreover, by the time science arrives at a point where it can describe the critical details of the impulse pattern of a mental experience in the functional terms and setting required, it will be describing, in effect, the conscious force or property itself. When we reach such a point, the conscious force will be recognized as such, and we shall be calling it just that—or at least that is the hypothesis I am putting forward.

Many readers will note my reliance throughout this discussion on the emergent concepts of T. H. Morgan and the corresponding configurational and field concepts of Gestalt psychology. The Gestalt schools of psychology and philosophy went wrong only when they moved into the brain and tried to transfer their pattern properties directly from the outside world and

sensory surfaces into the cerebral cortex. The central, emergent conscious force within the brain, as visualized here, is not a simple surrounding envelope, or volume property, or any other kind of "isomorph," as the Gestalt schools tried to make it. It is rather a functional pattern that has to be worked out in entirely new terms, that is, in terms of the functional circuitry of the brain, in terms of the still unknown brain code.

Above simple pain and other sensations in brain dynamics, we find, of course, the more complex but equally potent forces of perception, emotion, reason, belief, insight, judgment, cognition, and all the rest. In the onward flow of conscious brain states, one state calling up the next, these are the kinds of dynamic entities that call the plays. It is exactly these encompassing mental forces that direct and govern the inner impulse traffic, including its electrochemical and biophysical aspects. When trying to visualize mental properties as they have been described, it is important to keep in mind the fact that all of the simpler, more primitive, electric, atomic, molecular, cellular, and physiological forces remain present, of course, and they all continue to operate. None has been cancelled; but these lower level forces and properties have been superseded, encompassed, as it were, by those forces of successively higher organizational entities. We must remember in particular that, for the transmission of nerve impulses, all of the usual electrical, chemical, and physiological laws still apply at the level of the cell, the fiber, and the synaptic junction. We must remember further that proper function in the uppermost levels always depends on normal operation at subsidiary levels.

Near the apex of this command system in the brain — to return to more humanistic concerns — we find ideas. Man over the chimpanzee has ideas and ideals. In the brain model proposed here, the causal potency of an idea, or an ideal, becomes just as real as that of a molecule, a cell, or a nerve impulse. Ideas cause ideas and help evolve new ideas. They interact with each other and with other mental forces in the same brain, in neighboring brains, and thanks to global communication, in far distant, for-

eign brains. And they also interact with the external surroundings to produce in toto a burstwise advance in evolution that is far beyond anything to hit the evolutionary scene yet, including the emergence of the living cell.

In the proposed scheme, the interplay of psychic and mental forces, though accessible — like the interior of the earth — only indirectly at this date becomes, in principle, a proper phenomenon for scientific investigation. Aside from problems of complexity and adequate technology, there would seem to be no great obstacle in principle to the eventual objective, scientific treatment of mental phenomena. One may see statements in the literature these days discouraging the hope that the mind is capable of explaining itself in terms of its own ideas; the argument is that no machine, living or otherwise, can logically embody within itself a complete description of itself. When you read such statements, however, always underline that word "complete" and then consider the extent of the explanatory possibilities that still remain even though they fall somewhat short of complete. Underline also that word "itself" and remember that this kind of logic does not prevent a man's mind from acquiring a complete description of his neighbor's mind or from passing on this description to other neighbors, excepting only the one he has described.

For an outside, second, brain, however, to directly experience the subjective qualities in an observed brain, it would seem to be necessary for the detector brain in the observer to be coupled in parallel to the emitting brain and wired directly into the specialized cerebral circuitry involved. This does not look very feasible under ordinary conditions for the near future. However, we do seem to be approaching exactly this situation experimentally in recent studies in which the brains of cats and monkeys have been bisected down the midplane into right and left halves. In the surgical process, we may leave a few cross-connections, coupling selected cerebral centers between "mind-right" and "mind-left." When the midline disconnection is complete, two separate mentalities are the result, which sense,

perceive, learn, and remember independently. Each half seems to have its own realm of conscious awareness, and each is apparently as much out of contact with the inner experience of the other as are two brains in separate skulls. But when a band of cross-connections is left intact, linking, for example, the right and left centers for vision or those for touch sensibility in the hands, the inner, mental, subjective experience of the one brain seems to become available to the other.

Something of the kind can also be seen in studies of human patients who have had a similar surgical disconnection of the hemispheres for medical or therapeutic purposes and in whom cross-connections have been left intact between the lower brain centers involved in emotion and feeling. Whereas the cognitive, perceptual, mnemonic, and related experiences of mind-right in these people seem to be entirely out of touch with the corresponding experiences of mind-left, each brain half seems to share the emotional experience of the other. For example, if an emotion is triggered through vision by the introduction of an unexpected pin-up picture of a nude into a sequence of ordinary geometric pattern stimuli being projected into only one brain half, it is quite apparent from the verbal readout through the other half of the brain (that is, the one not directly excited) that this second hemisphere also feels properly embarrassed – or whatever the case may be. The second hemisphere, however, has no idea why it has these inner feelings and is unable to describe their source.

Looking back from this point, you will note that the earlier basic distinction or dichotomy between mentalism and materialism is resolved in this interpretation, and the former polar differences with respect to human values, when recast in the present scheme, become mainly errors of reductionism. This may be easily recognized as the old "nothing but" fallacy; that is, the tendency, in the present case, to reduce mind to nothing but brain mechanism, or thought to nothing but a flow of nerve impulses. For those acquainted with theories of mind, the new twist here, if any, is to be found in the attempt to make the emergent properties of inner experience conform to the inner brain

code, rather than to the outside world or subjective impressions or sensory patterns; combined, of course, with the critical interjection of these mental qualities into the causal sequence. Note that we have not rejected the objective approach of science; it is an objective explanatory model that we are discussing. Our quarrel is not with the objective approach but with the long accepted demand for exclusion of mental forces, psychic properties, and conscious qualities – what the physicist might class as "higher-order effects" or "co-operative effects" – from the objective scientific explanation.

The present scheme would put mind back into the brain of objective science and in a position of top command. If correct, it would eliminate the old dualistic confusions, the dichotomies and the paradoxes, proposing instead a single unified system extending from subnuclear forces near the bottom up through ideas at the top. As a scientific theory of mind, it would provide a long sought unifying view on which to base our conception of human nature, the kind of view whose lack has recently been deplored in leading articles in *Science* and elsewhere. Moreover, this scheme suggests a possible answer not only for the relation between mind and brain but also for that between the outside world and its inner cerebral representation, another conundrum since the days of Plato. When used as a conceptual skeleton on which to build a body of philosophy, this theory tends to favor somewhat a single "this world" measuring stick for evaluating man and existence. As for the older materialist doctrine, one can say, in summary, that the denial or downgrading of conscious mental forces in objective experimental psychology during the past half-century has been tremendously valuable and successful as a tactical expedient for a developing science. It is hardly a doctrine, however, on which to build societal philosophy and cultural values.

Free Will

Let us shift gears at this point and consider another outcome of the mind-brain sciences that appears to run a close second

in its threat to cherished images of human nature. This humanist "Enemy Number 2" to which I refer (some would rate it Number 1) is the scientific rejection of free will. Every advance in the science of behavior, whether it has come from the psychiatrist's couch, from microelectrode recording, or from the use of psychotropic drugs, brain splitting, Skinner boxes or the electron microscope, seems only to reinforce that old suspicion that free will is just an illusion. Like most others in brain research, I work on the assumption that every apparently free mental choice that I or anyone else has ever made must in fact have been causally predetermined in the preceding brain states and related events. This means that any decision in which any of us has ever engaged could not possibly have had any other outcome. It means none of us, hearing or reading these words, had any real chance to be doing anything else at this particular moment. It means that we are now and always have been imprisoned, as it were, in the inexorable onward march of causal determinism.

Attempts to restore free will to the human brain by recourse to various forms of indeterminacy – physical, logical, emergent, or otherwise – have failed so far as I can see to do more than introduce a bit of unpredictable caprice into our comportment that most of us would prefer to be without. Neither science nor philosophy seems able to refute the old admonition that "the moving finger writes; and, having writ, moves on." And piety, wit, and tears still seem impotent to change this situation. I do not feel overly comfortable about this kind of thinking any more than anyone else, but as yet I have not found any way out of it.

But before we start drawing gloomy humanist deductions from this apparent inevitability, concluding that moral responsibility is thereby removed or, on the other hand, simply rejecting science and determinism on emotional grounds, we should bear in mind a few additional points. In the present scheme, these points add up to the conclusion that if we really did have freedom of choice we might very likely prefer not to have; that is, we might well prefer to leave determinism in control, exactly as

science postulates. It should be clear by now that in the brain model described here, man is provided in large measure with the mental forces and the mental ability to determine his own actions. This scheme thus allows a high degree of freedom from outside forces as well as mastery over the inner cellular, molecular, and atomic aspects of brain activity. Depending on the state of one's will power, the model also allows considerable freedom from lower-level natural impulses and even from occasional thoughts, beliefs, and the like, though not, of course, from the whole complex. In other words, the kind of brain visualized here does indeed give man plenty of free will, provided we think of free will as self-determination. To a very real and large extent, a person does determine with his own mind what he is going to do from among a large number of possibilities. This does not mean, however, that he is free from the forces of his own decision-making machinery. In particular, what this present model does not do is to free a person from the combined effects of his own thoughts, his own reasoning, his own feeling, his own beliefs, ideals, and hopes, nor does it free him from his inherited makeup or his lifetime memories. All these and more, including, yes, unconscious desires, exert in the brain their due causal influence upon any mental decision, and the combined resultant determines the inevitable but self-determined and highly special and highly personal outcome. We thus come back to the question, Do we really want free will, in the sense of gaining freedom from our own minds, from our own selves, and hence, from everything most precious that makes us us?

There is a bit more to the story of how one may "learn to stop worrying about freedom and come to love determinism," but it boils down to the old saying, "If you can't lick 'em, join 'em." Or as Confucius might have said, "If fate inevitable, relax and enjoy." Or to put it more directly, "There may be worse fates than causal determinism." Maybe after all it is better to be imbedded firmly in the causal flow of cosmic forces, as an integral part thereof, than to be on the loose and out of contact with these forces – free-floating as it were – with behavioral

possibilities that have no antecedent cause and hence no reason or any reliability when it comes to future plans, predictions, or promises. I suspect, in fact, that if you were assigned the task of trying to design and build the perfect free-will model (let us say the perfect all-wise decision-making machine to top all competitors' decision-making machines), it is possible that you might decide that your aim should not be so much to free the machinery from causal contact as the opposite; that is, to try to incorporate into your model the potential value of universal causal contact – in other words, contact with all related information in proper proportion, past, present, and future.

In any case, it is clear that the human brain has come a long way in evolution in exactly this direction when you consider the amount and the kind of causal factors that this multidimensional, intracranial vortex draws into itself, scans, and brings to bear on the process of turning out one of its pre-ordained decisions. Potentially included, thanks to memory, are the events and collected wisdom of most of a human lifetime. We can also include, potentially, given a trip to the library, the accumulated knowledge of all recorded history. And we must add to all the foregoing, thanks to reason and logic, much of the future forecast and predictive value extractable for all this data. Maybe the total falls a bit short of universal causal contact, maybe it's not quite up to the kind of thing that evolution has going for it over on Galaxy Nine, and maybe, in spite of all, any decision that comes out is still predetermined. Nevertheless, it still represents a very long jump in the direction of freedom from the primeval slime mold, the Jurassic sand dollar, or even the latest 1965 model Orangutan.[1]

We may note in passing that on the debit side of the ledger there is little in our proposed model for consciousness to bolster one's hopes either for extrasensory perception or for post-mortem perception. Similarly, pre-partum perception in the embryo

[1] This paragraph and the preceding one are taken almost verbatim from an earlier article, *Problems Outstanding in the Evolution of Brain Function: James Arthur Lecture of the Evolution of the Human Brain* (New York: American Museum of Natural History, 1964).

may be presumed not to amount to much until after the requisite cerebral machinery for conscious awareness has begun to attain functional maturity in the later months of fetal life and in subsequent postnatal development.

Plasticity of Human Nature and Inheritance of Behavior Traits

Finally, in connection with development, I must mention briefly certain other advances in the brain-behavior sciences that have resulted in important revisions during the past two decades in our general conception of human nature. These advances have concerned the extent to which behavior traits can be inherited and the extent to which human nature is plastic and subject to shaping by experience and environment.

Through most of the first part of this century and up until about twenty years ago, the view prevailed that the brain gets its start in fetal life as an essentially equipotential network, functionally unstructured, a blank slate, as it were, which is then gradually channelized from early fetal movements onward by functional trial and error, practice, conditioning, learning, and experience. The objective, materialist movement in psychology, which was established first in Russia, largely under the influence of Pavlov, and which appeared soon afterward in this country, pioneered by Watson, under the name "behaviorism," has been identified almost as much with the promotion and idolatry of the conditioned response as it has with the demotion and vilification of consciousness. In this doctrine the mind, or psyche, was believed to develop gradually out of a life-long chain of successive conditioned-reflex associations, starting in the infant from a few elementary reactions, like love and hate, fear and anger. The whole idea of the genetic inheritance of behavior patterns was forcibly renounced, until the term "instinct" became highly discredited in professional circles, its defamation almost equalling that of consciousness. In those days, the embryonic growth of brain pathways was believed to be by nature non-selective and diffuse, and the establishment of precise fiber connections was held to be unimportant anyway for orderly

function. The nerve connections, once laid down, were thought to be able to undergo radical and wholesale rearrangement by surgery, injury, and regeneration without disrupting orderly function. In the scientific thinking of those times, the brain was endowed with an almost mysteriously omnipotent plasticity and readaptation capacity. In general, science seemed to be telling us through the twenties and thirties and into the early forties that the human brain and human nature as well were extreme in their malleability. It seemed at that time a scientifically sound conclusion that it would be possible, by means of an appropriate program of training and environmental conditioning, to shape human nature, and hence society, within wide limits into a desired mold.

Much of the basic scientific thinking and evidence behind this view has since suffered a series of severe upsets, leading to a current stand that is almost diametrically opposed to the earlier doctrines. Instead of a loose, universal plasticity in brain hookups, we now see a basic built-in wiring diagram, characteristic of the species and functionally rather rigid. Instead of diffuse, non-selective growth of nerve connections in brain development, we now see a very precise and highly ordered patterning of brain fiber pathways and connections, all strictly preregulated by specific genetic effects and cytochemical affinities. Where there used to be an outright denunciation of the whole concept of "instinct," we now accept the idea that an entire evolutionary tree can be worked out on the basis of inherited behavior patterns, just as it can be worked out on the basis of morphological or serological traits. The conditioned response, along with other forms of learning, continues to be recognized, of course, as a highly powerful modeling influence, especially in man, but only within limits much narrower than previously supposed.

Within the specialized fields of scientific inquiry involved here, the pendulum of opinion continues at this date to swing in the direction of inheritance. How far it will go can only be guessed. It is still too soon for the implications to have fully permeated even the neighboring scientific disciplines. What implications these changes in the basic brain-behavior sciences may have, if any, for more distant problems in the social sciences will take much longer to evaluate. The latter, of course, will have to be worked out in their own right and at their own level. In any case, it would seem that the evidence available today says that we should renounce, along with other aspects of the behaviorist, materialist approach discussed above, the old Pavlovian-Watsonian conditioned-reflex theory of the psyche, with its radical environmentalism that used to tell us that literally 99 per cent of human nature and mind is a product of experience and training.

Our re-examination of the materialist doctrine in psychology could be extended much further into matters far removed from those in which brain researchers feel at all comfortable. Let me only remind my readers that the peck-order of causal entities does not stop within the individual brain but goes on up into higher levels involving society and culture, various subentities of which must be properly credited with many of man's most remarkable and fantastic achievements.

Reference to society brings, of course, the pressing reminder that any attempt to upgrade human nature through a more idealistic conception of mind is bound these days to be overwhelmingly counteracted by the cold laws of mathematics and the devastating downgrading effect of surplus numbers on the worth of the individual. We do not need the third law of psychodynamics to tell us that the optimum carrying capacity of our globe is perhaps already exceeded from the standpoint of quality, dignity, meaning, and value for the human individual. When we look at the rising threat posed by the effects of human surplus and its by-products on the hard-won and painstaking achievements of eons of evolution, we are inclined to forget our little ideological skirmish with materialism, along with most of the human betterment efforts of our times, as just another losing battle in the face of mounting humanity – effort down the drain, until some higher force in our mental hierarchy than natural impulse can be brought to bear.

When it comes to the future outlook and an attempt to make

predictions regarding the future of man, behavioral science is hampered by a technical difficulty, in that once the prediction is published and man becomes acquainted with what he is supposed to do, he is in a position to take the prediction into account and is apt to be just perverse enough to do the reverse. Keeping this in mind, we can forecast that our generation and future generations need not really worry about surplus numbers, or who will outbreed whom, or any of the other problems we have touched on above, because these and related matters promise to be settled shortly in that final fatal flare of fission fireworks.

But to return to the central concern of this essay – the impact of creeping materialism in the brain-behavior sciences – we can say in summary that it is possible to see today an objective, explanatory model of brain function that neither contradicts nor degrades but rather affirms age-old humanist values, ideals, and meaning in human endeavor. The noble, free, or heroic, the exalted or sublime, qualities – or the opposite, for that is how meanings arise – that the humanist formerly thought he could see in man and his activities are present in our model, much as history and common experience have always shown. Finally, for those who like to receive a take-home lesson, that of the foregoing is simple for scientist and humanist alike: Never underestimate the power of an ideal.

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